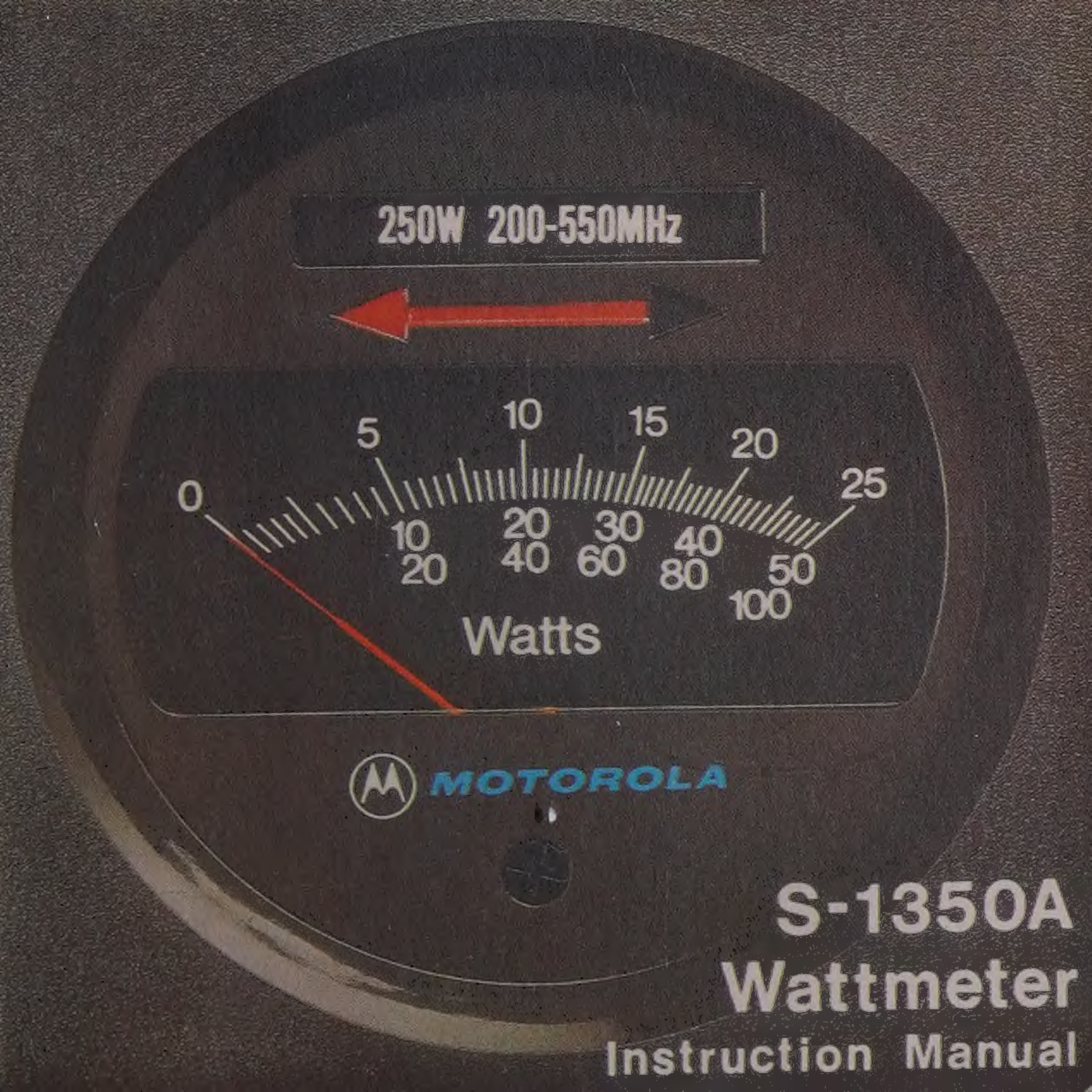

S-1350A Wattmeter

Instruction Manual

S-1350A
Wattmeter

MOTOROLA INC.
Communications Division

SERVICE PUBLICATIONS 1301 E. ALGONQUIN ROAD SCHAUMBURG, ILLINOIS 60172

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foreword

1. SCOPE OF MANUAL

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date.

2. MODEL AND KIT IDENTIFICATION

Motorola equipments are specifically identified by an overall model number on the nameplate. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them. When a production or engineering change is incorporated, revision suffix numerals are added to the affected kit model number. For example, a TLN4448A becomes a TLN4448A–1 with the first revision, TLN4448A–2 with the second revision, etc.

As diagrams are updated, information about the change is incorporated into a revision column. This revision column appears in the "up-issued" manual

next to the parts list or, in some cases, on the diagram. It lists the reference number, part number, and description of the parts removed or replaced with the suffix number changed. With this information, the technician can find the information for the current version, and any previous version, of the equipment covered by the manual.

3. SERVICE

Motorola's National Service Organization offers the finest nationwide installation and maintenance program available. The organization includes over 800 strategically-located Motorola Service Stations (MSS) each having a trained staff of FCC-licensed technicians.

The administrative forces of area and district service managers, and district service representatives, are in the direct employ of Motorola.

Should you wish to purchase a service contract for your Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager
Motorola Communications Division
1301 E. Algonquin Road
Schaumburg, IL. 60172

4. REPLACEMENT PARTS ORDERING

Motorola maintains a number of parts offices strategically-located throughout the United States. These facilities are staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Division products.

Orders for all parts should be sent to the nearest area parts center. Orders for instruction manuals should also be sent to the area parts and service center.

When ordering replacement parts or equipment information, the complete identification number should be included. If the component part number is not known, the order should include the number of the chassis or kit of which it is a

part, and sufficient description of the desired component to identify it.

5. LIMITED WARRANTY (MOTOROLA S–1350A WATTMETER AND ASSOCIATED ELEMENTS)

The Motorola S-1350A Wattmeter is warranted to be free from defects in workmanship and material for a period of ninety (90) days from date of shipment. Associated elements are warranted to be free from defects in workmanship and material for a period of one (1) year from date of shipment. This express warranty is extended by Motorola Communications and Electronics Inc. (Motorola), 1301 East Algonquin Road, Schaumburg, Illinois 60172, to the original purchaser only. In the event of a defect, malfunction, or failure to conform to the above specifications during the warranty period, Motorola

Communications and Electronics Inc., at its option, will either refund the purchase price, repair, or replace the wattmeter or associated element.

To obtain such remedies, the wattmeter or element must be delivered along with proof of purchase and date of shipment (packing list or invoice) and an appropriately filled out claim form to the Motorola Communications Division Parts Department at 10 West North Avenue, Lombard, Illinois 60148, Attention: Return Goods, or to a designated Motorola Area Parts Office *between 9 A.M. and 4 P.M. Monday through Friday exclusive of holidays. (Address of Parts Offices are available from the Motorola Communications Division Parts Department, and claim forms are available from both the Parts Offices and the Parts Department.)* Purchaser shall pay for any transportation charges incurred in delivering units to Motorola. Motorola will pay for any transportation charges incurred in returning units to the original purchaser.

This warranty is void if:

a) The wattmeter or associated elements have not been

operated as originally intended for the service and maintenance of radio communications equipment in accordance with the procedures described in the operating instructions;

b) the seals on the wattmeter or element are not intact;

c) the wattmeter or element has been intentionally or unintentionally subjected to physical or electrical abuse, improperly operated, misused, damaged or the subject of accident, negligence, repair or alteration.

Element RF Connectors are not warranted against mechanical or electrical failures, such as stripped threads or open circuits, which could have been caused subsequent to shipment.

IN NO EVENT WILL MOTOROLA BE LIABLE FOR CONSEQUENTIAL DAMAGES FOR FAILURE OF OR DEFECT IN THE WATTMETER OR ASSOCIATED ELEMENTS.

All obligations will be performed by Motorola within a reasonable time not to exceed 90 days from date of receipt of unit and required documents at Motorola.

This warranty gives you specific legal rights. You also have implied warranty rights. In the event of a problem with warranty service or performance, you may be able to go to a small claims court, a State court, or a Federal district court, but before doing so we hope you will communicate directly with the Motorola Inc. Communications Division Parts Department so that we can make every effort to see that you are satisfied with your purchase.

This is the full and complete *express* warranty for the Motorola S-1350A Wattmeter and associated elements; and Motorola assumes no obligation or liability for any additions or modifications to the above warranty unless made in writing and signed by an officer of Motorola.

Motorola Communications and Electronics Inc.
1301 East Algonquin Road
Schaumburg, Illinois 60172

general

1. FEATURES

- Measure CW or FM power.
- Measure AM or TV power at zero modulation.
- Power measurements from 1-1000 watts in the 25-1000 MHz range.
- Read wattage on a taut-band meter with large high resolution viewing area by simply clipping the meter over an in-line element.
- Low-cost elements may be left in antenna or transmission lines, eliminating the need to go off-the-air when measuring power.
- Separating unit from element automatically damps the meter, for positive protection against mechanical shock during transit.
- Each element provides a wide frequency range... so fewer elements are needed to service all radio communications bands.
- Rugged, sealed elements have long trouble-free lives and cannot lose calibration.
- RF cavity and sense lines are an integral part of the element, eliminating variations in accuracy, VSWR

(voltage standing wave ratio), and losses in the measurement system throughout the life of the element.

– In-line elements are designed around a bi-directional coupler concept allowing power to be measured in either direction (forward or reverse) with the flick of a switch.

2. SPECIFICATIONS

Frequency Range:	25 MHz to 1000 MHz with appropriate elements
Power Measurement Ranges:	1 W to 1000 W with appropriate elements
Accuracy:	±5% of full scale
Impedance:	50 ohms
VSWR:	Less than 1.05:1 → 1.0:1
Insertion Loss:	~~Not measurable~~ < 1db @ 1w LEVEL
Minimum Directivity:	25 dB
Connectors:	"N" and "UHF" type (refer to Table 1)
Dimensions (HxWxL):	Housing - 4" x 4" x 3" (Less Feet) Elements - 1" x 1¼" x 5¼"
Weight:	Meter Housing: ¾ lb. Elements: ¾ lb.
Temperature Range:	0 - +70°C

3. PURPOSE AND APPLICATION

3.1 The S-1350A Wattmeter is an insertion type rf wattmeter designed to measure CW or FM power as well as AM or TV power at zero modulation. This wattmeter cannot measure pulsed powers. When used in 50-ohm matched applications, the wattmeter inserts minimal loss into the measured line due to a low VSWR (less than 1.05:1) across any frequency range from 25 MHz to 1000 MHz. The meter reads directly in watts with expanded graduated 25, 50, and 100 watt full scale deflections for easy reading. The power ranges are determined by the element cavities which fall into four frequency ranges and ten power ranges. Refer to Table 1 for element summary.

3.2 The wattmeter housing does not incorporate the traditional rf cavity in its housing. It is a measuring system designed only to accept an element which is an rf cavity and sense line combined into a single unit, thereby eliminating variations in accuracy, VSWR, and losses in the measuring system due to imperfect matches. The ele-

ments retain rf integrity by not exposing the cavity. The meter housing makes provisions for retaining the elements securely. The output of the elements is picked up by three contacts in the meter housing and applied to the meter for a direct power reading. Forward and reflected power is measured by selecting the direction of the sense with a switch on the meter housing. There is no need to rotate or reconnect the elements. The elements are bi-directional so that the transmitter or the load can be applied to either end of the element with equal performance.

4. DESCRIPTION

4.1 The S-1350A Wattmeter, Figure 1, is a portable unit contained in a high impact plastic housing. The back of the housing contains a removable panel for easy access to the internal parts for maintenance or repair. Four rubber shock feet on the base and four rubber bumpers on the back allow the wattmeter to stand or lie flat when used. A zero adjust is provided on the lower front face of the meter for zeroing the pointer, should it become necessary.

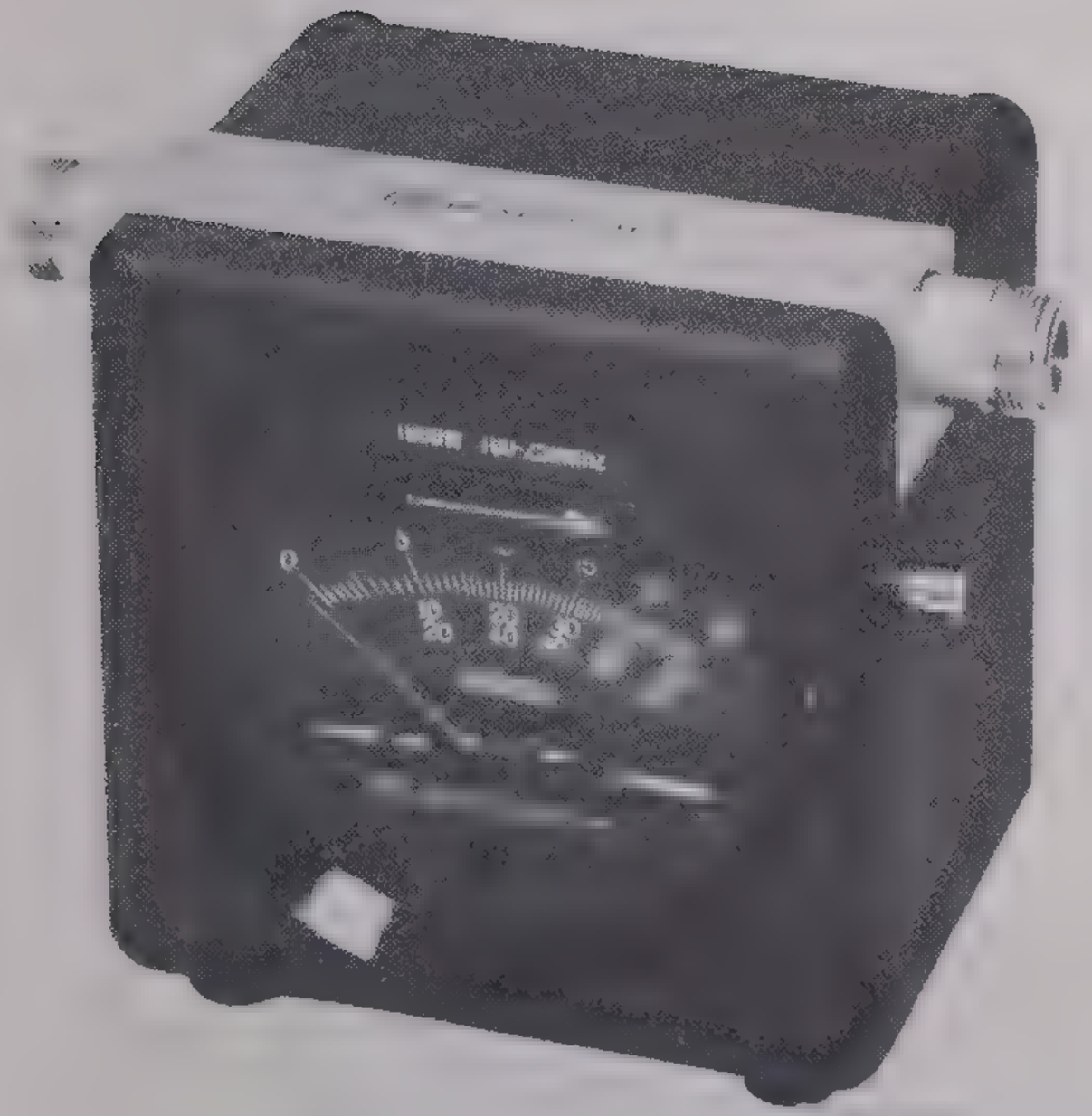


Figure 1. S-1350A Wattmeter

4.2 To make measurements, the rectangular shaped element is inserted fully into the "U" channel socket of the meter housing until the element is properly seated.

Since the element is bi-directional, it may be inserted without regard to transmitter or load direction. Three contacts at the bottom of the "U" channel mate with the three contact plates on the element itself. Appropriate connections are made to the elements and the meter coupling direction is selected.

4.3 The frequency and power range of the element are visible through a window on the meter face plate so that all necessary information can be seen directly from the front of the meter.

installation

1. PORTABILITY

1.1 The S-1350A Wattmeter (refer to Figures 2 and 3) is a portable instrument. Its housing is not designed for fixed or permanent mounting. Convenient carrying cases are available as options.

1.2 During transit, it is best to remove the plug-in element from the wattmeter. Removing the element automatically shunts the meter circuit and serves to protect the meter movement by damping the needle action. The plug-in elements should be handled with care. Although the calibration cannot be disturbed by average shock and vibration, it is best to avoid rough handling.

2. CONNECTIONS

2.1 The S-1350A Wattmeter itself is not inserted directly into the transmission line. The self-contained element (refer to Figures 4, 5, and 6) is the only unit that is directly inserted in the transmission line for power measurement. Since the element is bi-directional in operation and construction, it is indifferent to which side the power source or the load connection is made. It is imperative that 50-ohm cables be used, otherwise, a mismatch will occur and cause inaccurate readings and a high VSWR.

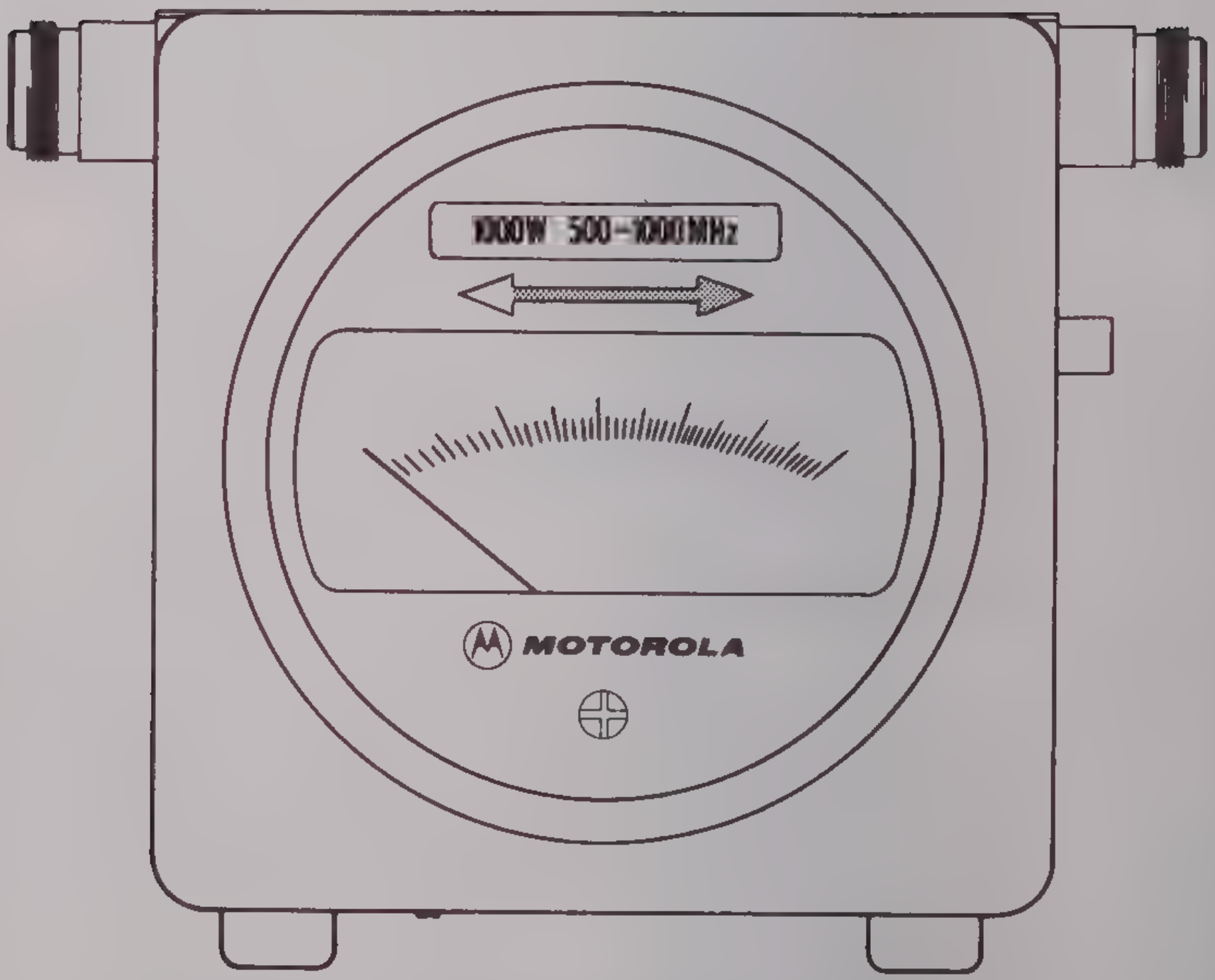


Figure 2. S–1350A Wattmeter, Front View

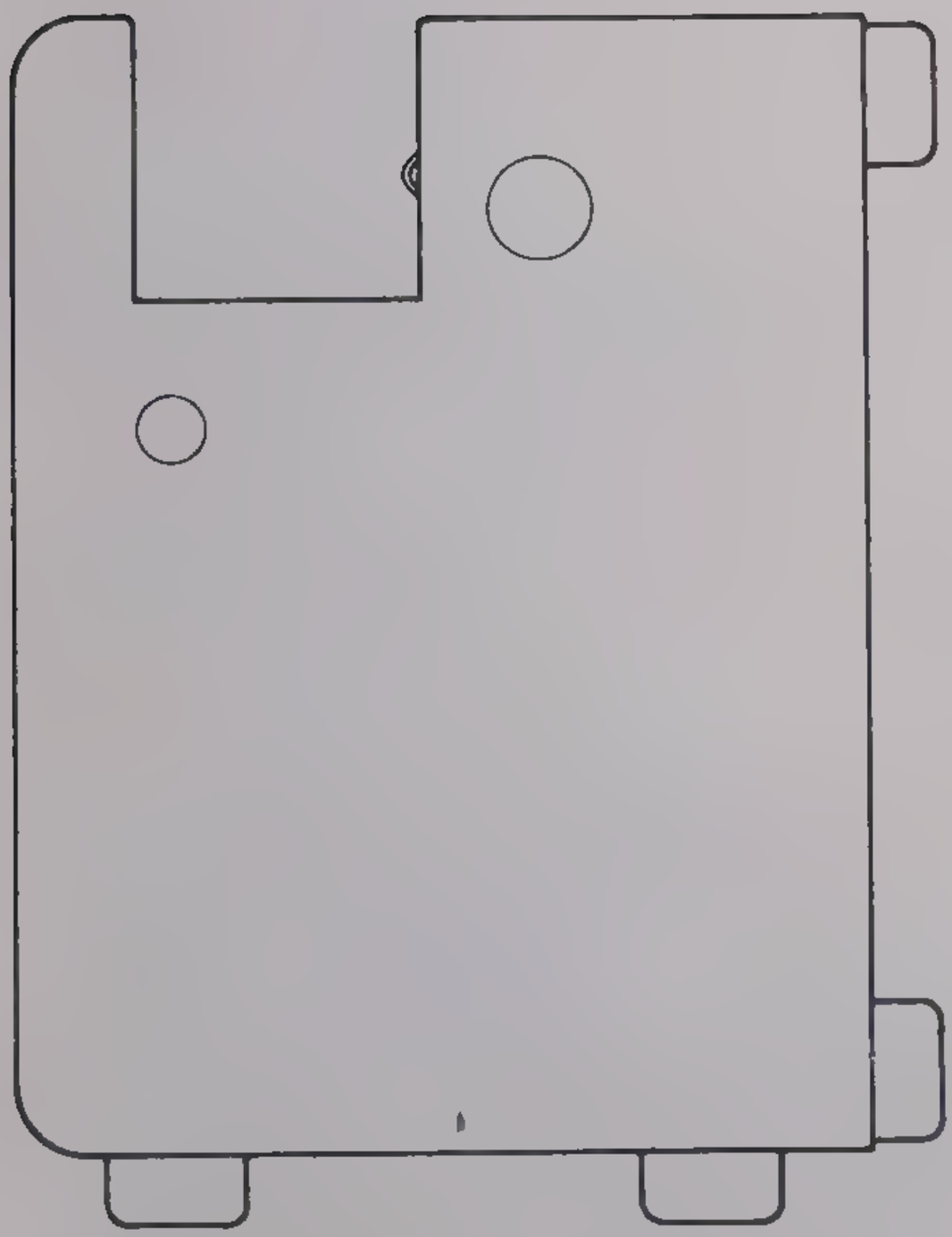


Figure 3. S–1350A Wattmeter, Side View

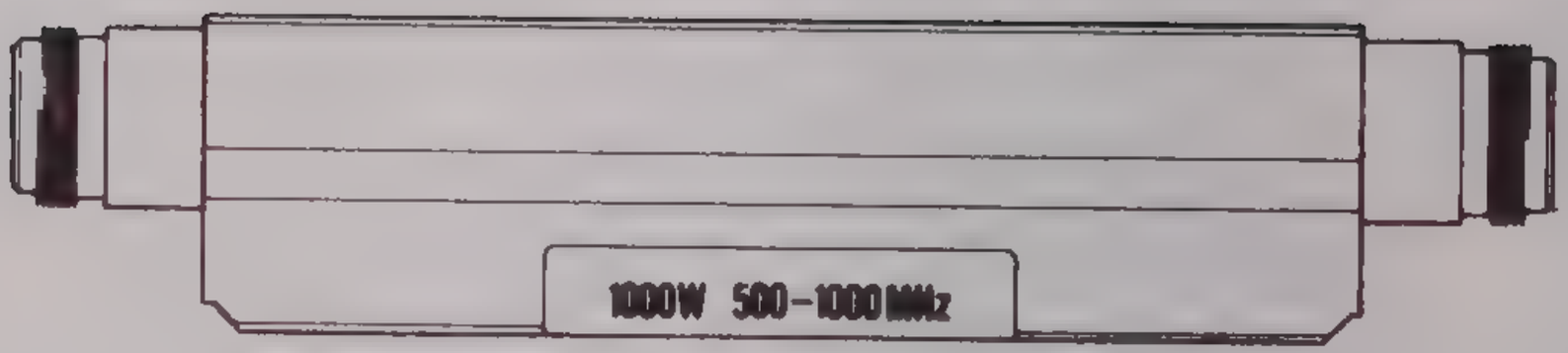


Figure 4. Self-Contained Element, Side View

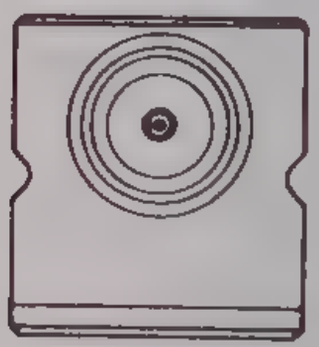


Figure 5. Self-Contained Element, End View

Figure 6. Self-Contained Element, Top View

2.2 Two types of connectors are normally available with the elements, female N-type or female UHF-type. These connectors are not of the quick change variety and are a permanent part of the cavity thus allowing the rf integrity of the element to remain constant If terminations to other than N or UHF connectors are desired, adapters are available for this purpose.

3. REMOTE INSTALLATION

3.1 As mentioned previously, the meter housing is a simple measuring unit with the element being a separate self-contained cavity and sense line. Only the element is inserted into the transmission line.

3.2 For permanent installation, insert the element into the appropriate line. For permanent installations indoors or within equipment, protection is not necessary other than to prevent contaminants from touching the gold dc contacts.

3.3 In some cases it may be desirable to have two or more elements permanently installed in continuous operating equipment. This again may be done as described above without affecting the integrity of the transmission line.

3.4 To make a rapid reading in permanent installations, it is only necessary to clip the meter housing over the element to make a power reading. It is best to assure that enough clearance is available around the permanently installed element to allow for meter housing accessibility. A minimum space of 6" x 6" x 4" is all that is required.

theory of operation

1. TRAVELING WAVE DISCUSSION

1.1 DISTRIBUTED CONSTANTS OF A LINE

1.1.1 Transmission lines are most easily analyzed by an extension of lumped-constant theory. The most important constants of the line are its distributed inductance and capacitance. When a current flows in the conductors of a transmission line, a magnetic flux is set up around the conductors. Any change in this flux will induce a voltage. The inductance of the transmission line conductors is distributed throughout their length. The distributed inductance is given the symbol L and is expressed in henrys per unit length.

1.1.2 Between the conductors of the line there exists a uniformly distributed capacitance C which is measured in farads per unit length of line. The distributed inductance and capacitance is illustrated in Figure 7. When the line is viewed in this manner, it is not difficult to see that the voltage and current can vary from point to point on the line and that resonance may exist under certain conditions.

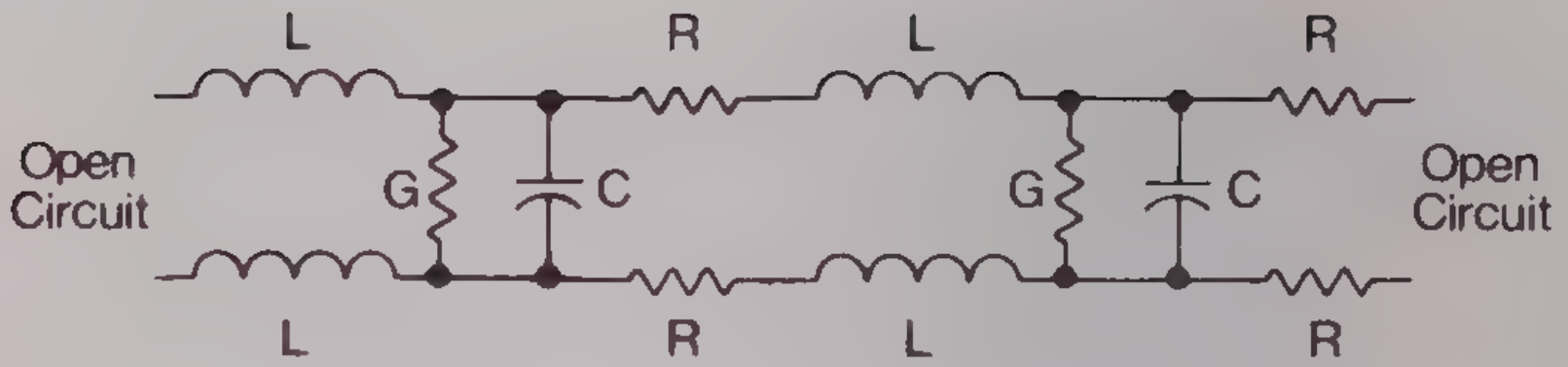


Figure 7. Distributed Constants of a Line

1.1.3 In addition to inductance and capacitance, the conductors also have a resistance of R-ohms per unit length. This includes the effect of all the conductors. Finally, the insulation of the line may allow some current to leak from one conductor to the other. This is denoted by a conductance G.

1.2 TRAVELING WAVES ON A LOSSLESS LINE

1.2.1 Consider the hypothetical case of a line without loss for which R = G = 0. This approximation is reasonably good when line losses are much smaller than the energy that travels along the line. When the inductance and capacitance of a pair of conductors separated by an insulator is

calculated, it is found that the LC product is independent of the size and separation of the conductors and depends only on the dielectric constant and permeability of the insulating medium.

1.2.2 The L and C quantities are characteristics of the line, and the $\sqrt{L/C}$ combination is called the "characteristic impedance." of a lossless line. This is denoted by the symbol Z_o. The characteristic impedance of a lossless line is real, that is, it is a resistance and is independent of frequency. For lines with loss, the characteristic impedance is not independent of frequency.

1.2.3 It was demonstrated that uniform lossless lines can support a wave of voltage which travels at the speed of $1/\sqrt{LC}$ in the positive direction and that this voltage is accompanied by a similar wave of current. Since the uniform line appears identical in either direction, we expect that the line can also support a wave traveling in the opposite direction.

1.3 REFLECTIONS

1.3.1 Figure 8 shows one end of a transmission line terminated in an impedance Z_t.

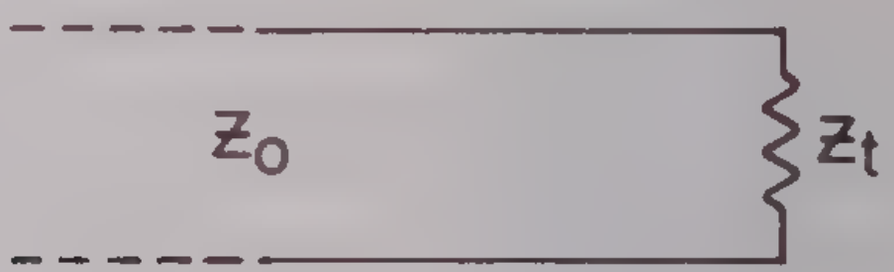


Figure 8. Terminated Transmission Line

1.3.2 Assuming the termination is pure resistance, it is independent of frequency. Assume an incident wave of voltage (which shall be denoted by V^+), traveling toward the load, accompanied by a current $I^+ = V^+ / Z_o$. At the load or the termination, the relationship must be

$$\frac{\text{Total V}}{\text{Total I}} = Z_i$$

Unless Z_t is numerically equal to Z_o, the relationship for a transmission line is not satisfied. Part of the incident

wave will be reflected. If the reflected voltage and current are labelled V^- and I^-, the relationship is $I^- = V^-/Z_o$. At the load this can be expressed as

$$\frac{V_i^+ + V_i^-}{I_t^+ + I_t^-} = Z_t$$

Rewriting the equation in terms of Z_o, and solving for the ratio of reflected to incident voltage, we obtain

$$\frac{V_t^- = Z_t - Z_o}{V_i^+ \quad Z_t + Z_o} = K$$

The ratio "K" is called the reflection coefficient. "K" will be zero and there will be no reflection at the load (or the termination) only when the terminating impedance is equal to the characteristic impedance of the line. Thus, a terminating impedance different from Z_o will give rise to a reflected wave which travels away from the termination. The reflection, upon reaching the other end, will itself be reflected if the terminating impedance at that end is also different from Z_o.

1.3.3 The magnitude of each reflection is obtained by multiplying the magnitude of the preceding wave by the reflection coefficient at the point where reflection takes place. In time, each successive reflection will be much smaller in magnitude and will reach zero (all energy totally absorbed).

1.4 STANDING WAVE RATIO (VSWR)

1.4.1 The relative magnitude of a reflected wave on a low-loss line is generally expressed by means of the standing wave ratio ρ, being defined as

$$\rho = \left| \frac{V_{max}}{V_{min}} \right|$$

where $|V_{max}|$ is the absolute value of the voltage at the highest point on the standing wave pattern and $|V_{min}|$ is the absolute value of the voltage at the lowest point of the pattern. A flat lossless line, which has no reflected wave, has $|V_{max}| = |V_{min}|$ and a standing wave ratio of 1.0. The ratio becomes larger without limit as complete

reflection is approached. On a low-loss line, this ratio is relatively constant and the standing wave ratio is a simple relation of the magnitude of the reflection coefficient.

1.4.2 A more simplified relationship for ρ is given as

$$VSWR = \frac{1 + \sqrt{\frac{\text{Reflected Power}}{\text{Incident Power}}}}{1 - \sqrt{\frac{\text{Reflected Power}}{\text{Incident Power}}}}$$

1.4.3 The VSWR value can be obtained much more rapidly by determining the percent of incident power which is being reflected and using the value obtained in conjunction with Graphs 1 through 4. The value of reflected power is

$$\% \text{ Reflected Power} = \frac{\text{Reflected Power}}{\text{Incident Power}} \times 100$$

2. CIRCUIT THEORY

2.1 The circuitry that couples and samples the traveling waves is located in the element. The physical relationship and element circuitry is shown in Figure 9.

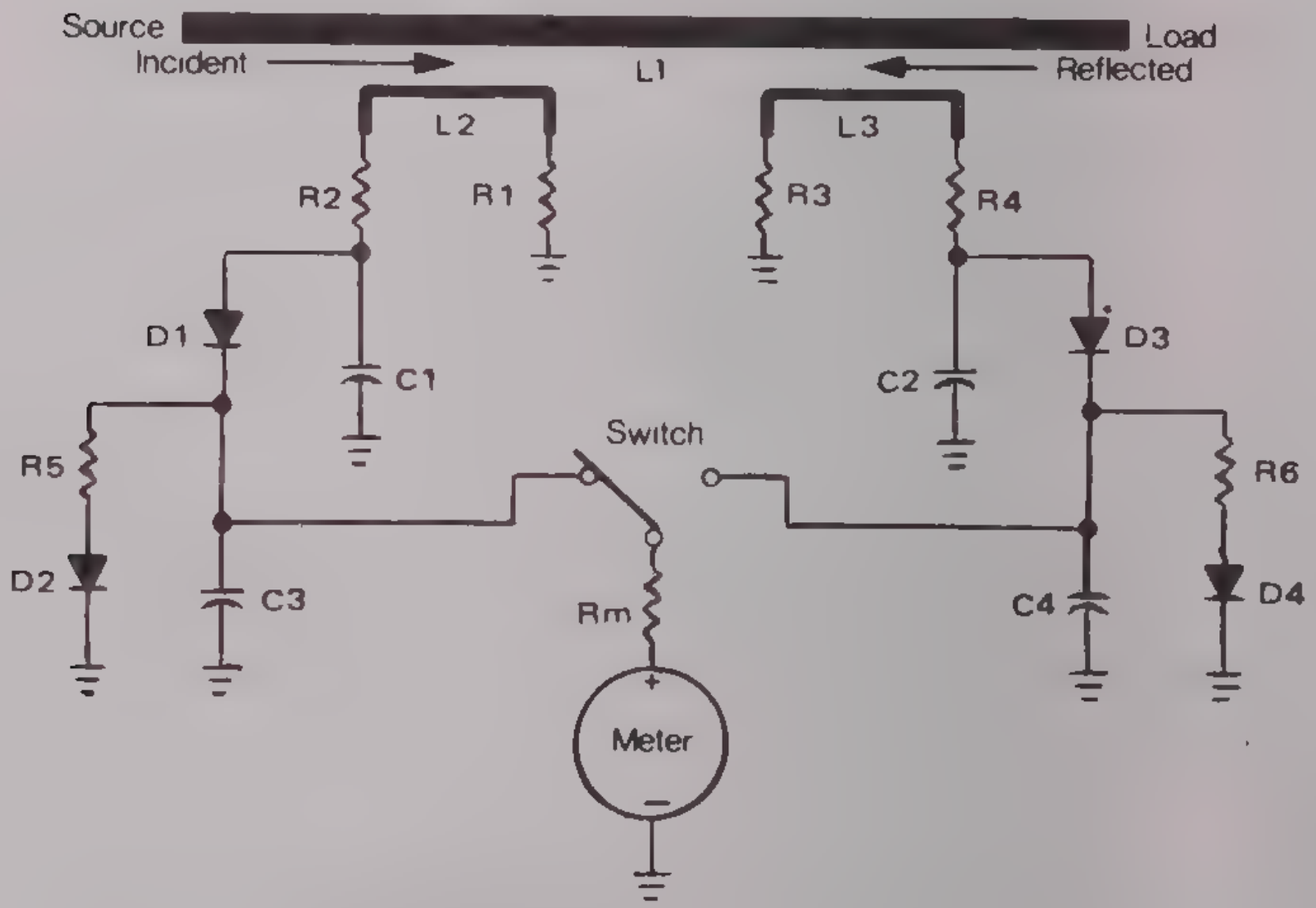


Figure 9. Element Schematic Diagram

2.2 As described in the preceding Traveling Wave Discussion paragraph, energy or voltage is produced in the coupling circuit of the element by mutual inductance and capacitance from the traveling rf waves of the line section. As discussed earlier, the inductive currents flow in accordance with the direction of the traveling waves producing them and the capacitive portion of the currents is independent of the traveling waves. Since the element is fixed in position, the coupling currents produced from the waves in one direction are added in phase and those produced from waves of the opposite direction will subtract in phase. Both of these occur simultaneously due to the dual coupling circuits.

2.3 The electronics of the element circuits are carefully selected, balanced, and designed, resulting in a minimum directivity of 25 dB. This means that the element is insensitive to the "reverse" direction wave in either of the two coupling circuits. Being highly directional, the element is sensitive only to the traveling wave which produces standing waves by interference.

NOTE

The detailed circuit theory begins with a discussion on the physics of a cavity.

2.4 Referencing Figure 9, the cavity used in the element is a zinc casting with a cylindrical bore, through which a radiating rod is positioned, coupled to, and accurately held in place by, two connector assemblies at each end of the element. This assembly forms a 50-ohm transmission line which is inserted between an rf energy source and a load (resistive or antenna type). The impedance of this cavity assembly is 50 ohms and calculated by the formula

$$Z_o = 138 \log \frac{D_1}{D_2} \cdot \frac{1}{\sqrt{K}}$$

where D_1 = inside diameter of cavity bore
D_2 = outside diameter of radiating rod
K = constant

2.5 Because the impedance of the cavity assembly and the line section are closely matched, any resulting VSWR is low, inserting no appreciable energy loss in the cavity. If the cavity exhibited any appreciable loss, the readings obtained from the wattmeter system would be inaccurate and invalid. Likewise, any loss would cause standing waves which would be added or subtracted, depending on phase, to any standing waves reflected from the load, causing further erroneous readings.

2.6 The sensing or coupling circuit will now be discussed. (Refer to Figure 9.) The sensing circuit consists of non-resonant loops (L2, L3) positioned above the radiating rod at a fixed distance determined by the maximum power which is to be measured. The loops are terminated in their characteristic impedance by resistors R1 and R3. The absolute accuracy of the termination resistor determines the overall directivity of the pick-up loop circuit. As mentioned above, directivity is the ability of the circuit to discriminate between the forward and reflected wave components. When a wave is generated and travels down the radiating rod, it induces a small voltage

into L2 or L3. This induced voltage is applied to R2 and C1 or R4 and C2. The RC combinations form a low pass filter which maintains approximately the same voltage across the capacitor (as frequency is changed). In other words, this is a frequency compensating network.

2.7 The induced voltage is rectified by diode D1 or D3 and the resulting pulsating dc voltage is filtered by capacitor C3 or C4. The dc voltage is applied to the meter through the forward/reverse switch. This switch selects either the forward or reverse power sensing circuit.

2.8 The combination of R5, D2 and R6, D4 comprise a voltage and temperature compensating circuit for the element. When the voltage increases to a point where it may damage the meter, it is kept constant across R5 and R6.

2.9 The diodes used in the element design, D1, D2, D3 and D4 exhibit extreme minimal forward voltage variations over a wide range of forward current. Therefore, the rectified voltage to the meter is relatively independent of the diode current. The result is meter scale accuracy unaffected by varying forward diode voltages.

operation

1. GENERAL

1.1 The wattmeter features and installation have been discussed in the GENERAL and INSTALLATION sections of this manual, respectively. As previously discussed, measurements are made by the insertion and operation of the elements and meter housing.

1.2 The elements determine the power range of the meter scale. The use of the appropriate scale markings determine the full scale power value for the element. The frequency of the source must be within the frequency bandwidth of the element used. Refer to Table 1 for proper element identification.

1.3 It must be remembered that the selection of an element connector-type determines total usefulness of that element in the measuring system. For this reason Motorola recommends that only N-type connectors be used for all measurements since they have a 50-ohm characteristic impedance and match the transmission or antenna line. For those situations requiring connections to a UHF-type

termination, it is advisable to remember that a UHF connector does not have a 50-ohm impedance and will insert some VSWR and some loss. Adapters are not recommended, and their usage should be selectively and cautiously applied.

1.4 Since the element is bi-directional, there are no transmitter/load designations on the element. Either side can be connected to the load.

CAUTION

It is important that the power range of the element exceeds the maximum power which may be transmitted through it. Serious damage to the element, as well as probable damage to the measuring meter, may occur. *Always* observe this precaution.

1.5 To insert the element into the meter housing, position the meter below the element and carefully push the element into the housing slot. It is *important*

that the element be seated correctly in the pocket to properly mate with the dc contacts.

1.6 It is important to remember the position of the transmitter/load to make appropriate and accurate use of the forward/reverse switch position on the meter housing. The direction of the arrow indicates the direction of the measurement being taken. For this reason, the position of the arrow is not important when power is first turned on, but the position of the arrow is important when making judgement on the value of the power flow. It is equally important to remember that the meter pointer be properly zeroed under no power conditions before taking any readings.

1.7 To remove the element from the meter housing, exert a straight upward pull on the element to clear the slot. Under no circumstances should the element be removed by a side-to-side motion as this may damage the retaining springs that hold the element in the housing. ALL ELEMENT EXTRACTION MUST BE DONE BY A STRAIGHT UPWARD MOTION.

2. LOAD POWER

2.1 To determine the power delivered to the load or antenna, subtract the reflected power from the forward power. The simple relationship is

$$P_{load} = P_{forward} - P_{reflected}$$

2.2 Visualizing the relative values of the forward and reflected powers demonstrates an actual situation. In matching problems, the primary goal is to minimize reflected power. The ratio of the readings, done mentally, is at times a satisfactory, even reliable, guide to the significance of load power.

maintenance

1. METER HOUSING

The housing that accepts the element is of a simple construction, is self-contained and requires a minimal amount of preventive maintenance.

One of the major precautions required is in the area of handling. USE REASONABLE CARE AND *DO NOT* DROP THE WATTMETER OR THE PLUG–IN ELEMENTS AS SEVERE DAMAGE MAY OCCUR IN SPITE OF THE DURABLE DESIGN OF THE EQUIPMENT.

A main factor in preventive maintenance of the wattmeter is care and cleanliness. Clean the window of the meter housing with a soft damp cloth. Do not allow the meter's face to come in contact with any tools or sharp objects. Provide sufficient protection to prevent water and dust from getting into the meter housing. Since the meter is automatically damped when an element is removed from the housing, it is recommended that the housing be transported without an element. The rugged taut band movement of the meter is sufficient to prevent any damage when subjected to reasonable shock and vibration.

If any of the dc contacts become dirty, they should be cleaned with a contact cleaner or any non-oily degreaser solvent. Use a cotton swab stick moistened with the solvent to clean contacts.

It is particularly important to prevent damage to the two side guide rails in the "U" channel as they guide the element into the slot and position it accurately over the dc contacts. Do not allow any tools or sharp objects to hit these two edges.

2. ELEMENTS

The element is a self-contained assembly which is non-repairable. It has been designed with the utmost consideration to durability. No recalibration is required over its lifetime. The calibration of the element will be retained even under the most severe shock and vibration. However, care must be exercised that the element not be dropped because any damage to the connector threads will render the element useless. For this reason, protect the element threads with the protective end caps that came with

the unit. If at all possible, retain the element in its protective shipping container or in the carrying case available as an option. Periodically, clean the gold contacts of the element to assure a clean mating surface to the meter housing.

Under no circumstances should any attempt be made to disassemble the element cavity. There are no replacement parts available for this unit as it is closely matched and assembled.

3. TROUBLESHOOTING

If occasional difficulties are experiences in the use of the wattmeter, refer to the following list of symptoms and probable causes.

Symptom	Probable Cause
No meter movement	No rf power Improper connections Element not completely inserted Dirty dc contacts

Symptom	Probable Cause
No meter movement	Contacts touching shorting bar Switch in reverse position Defective forward/reverse switch Defective or damaged meter Defective or damaged element
Intermittent, inaccurate or inconsistent meter readings	Improper load (not matched) Poor cable connections Poor or faulty transmission line Dirty dc contacts Intermittent shorting to the shorting bar Intermittent operation of forward/reverse switch Element not properly seated in slot Sticky or loose meter
High VSWR	Improper load Poor connections Shorted or open antenna or load lines

table 1.

Wattmeter Element Matrix

"N" TYPE CONNECTOR MODEL	"UHF" TYPE CONNECTOR MODEL	POWER (WATTS)	FREQUENCY (MHz)
ST-1200	ST-1240	1	25-100
ST-1201	ST-1241	2.5	
ST-1202	ST-1242	5	
ST-1203	ST-1243	10	
ST-1204	ST-1244	25	
ST-1205	ST-1245	50	
ST-1206	ST-1246	100	
ST-1207	ST-1247	250	
ST-1208	ST-1248	500	
ST-1209	ST-1249	1000	
ST-1210	ST-1250	1	100-250
ST-1211	ST-1251	2.5	
ST-1212	ST-1252	5	
ST-1213	ST-1253	10	
ST-1214	ST-1254	25	
ST-1215	ST-1255	50	
ST-1216	ST-1256	100	
ST-1217	ST-1257	250	
ST-1218	ST-1258	500	
ST-1219	ST-1259	1000	
ST-1220	ST-1260	1	200-550
ST-1221	ST-1261	2.5	
ST-1222	ST-1262	5	
ST-1223	ST-1263	10	
ST-1224	ST-1264	25	
ST-1225	ST-1265	50	
ST-1226	ST-1266	100	
ST-1227	ST-1267	250	
ST-1228	ST-1268	500	
ST-1229	ST-1269	1000	
ST-1230	ST-1270	1	500-1000
ST-1231	ST-1271	2.5	
ST-1232	ST-1272	5	
ST-1233	ST-1273	10	
ST-1234	ST-1274	25	
ST-1235	ST-1275	50	
ST-1236	ST-1276	100	
ST-1237	ST-1277	250	
ST-1238	ST-1278	500	
ST-1239	ST-1279	1000	

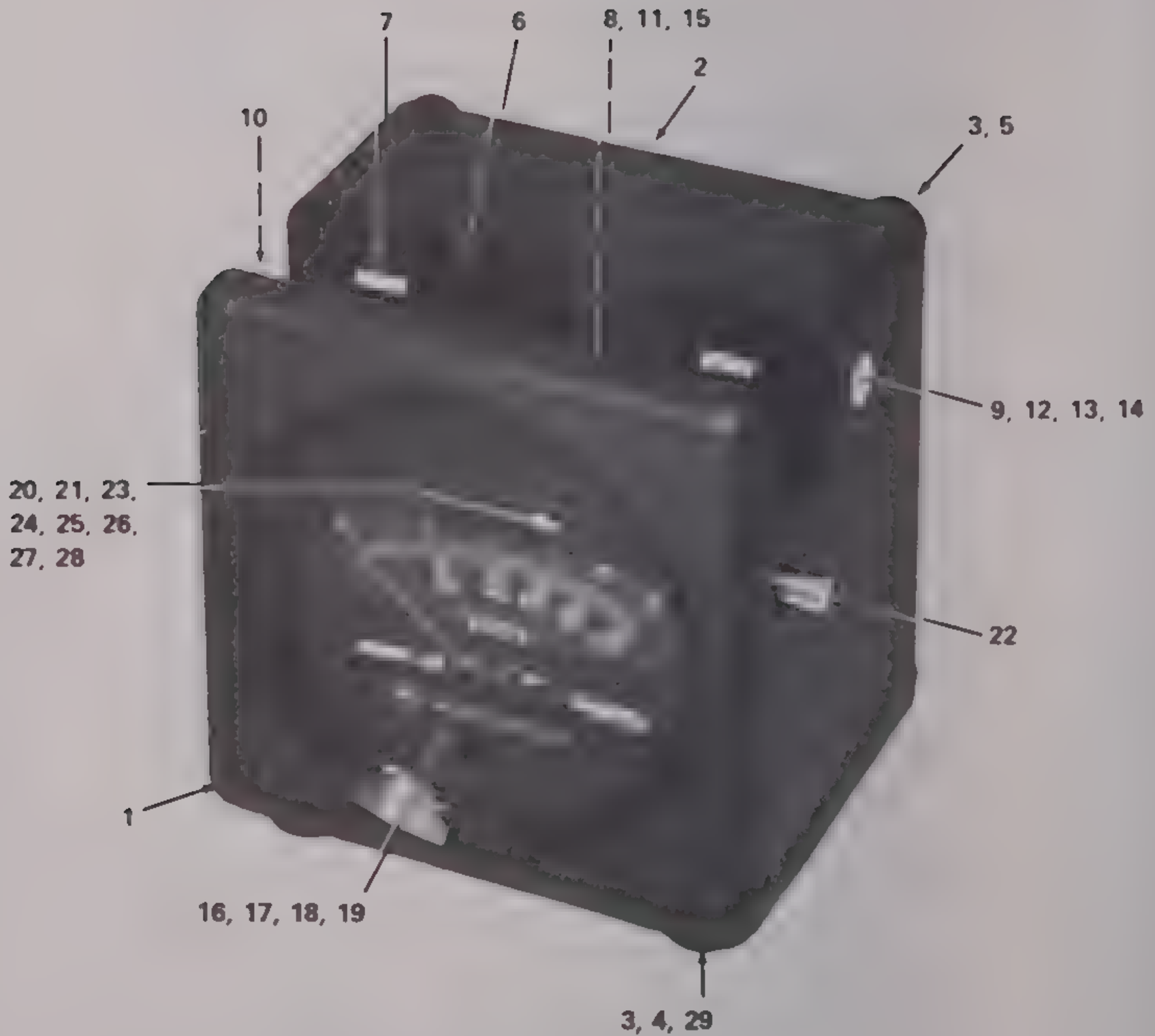
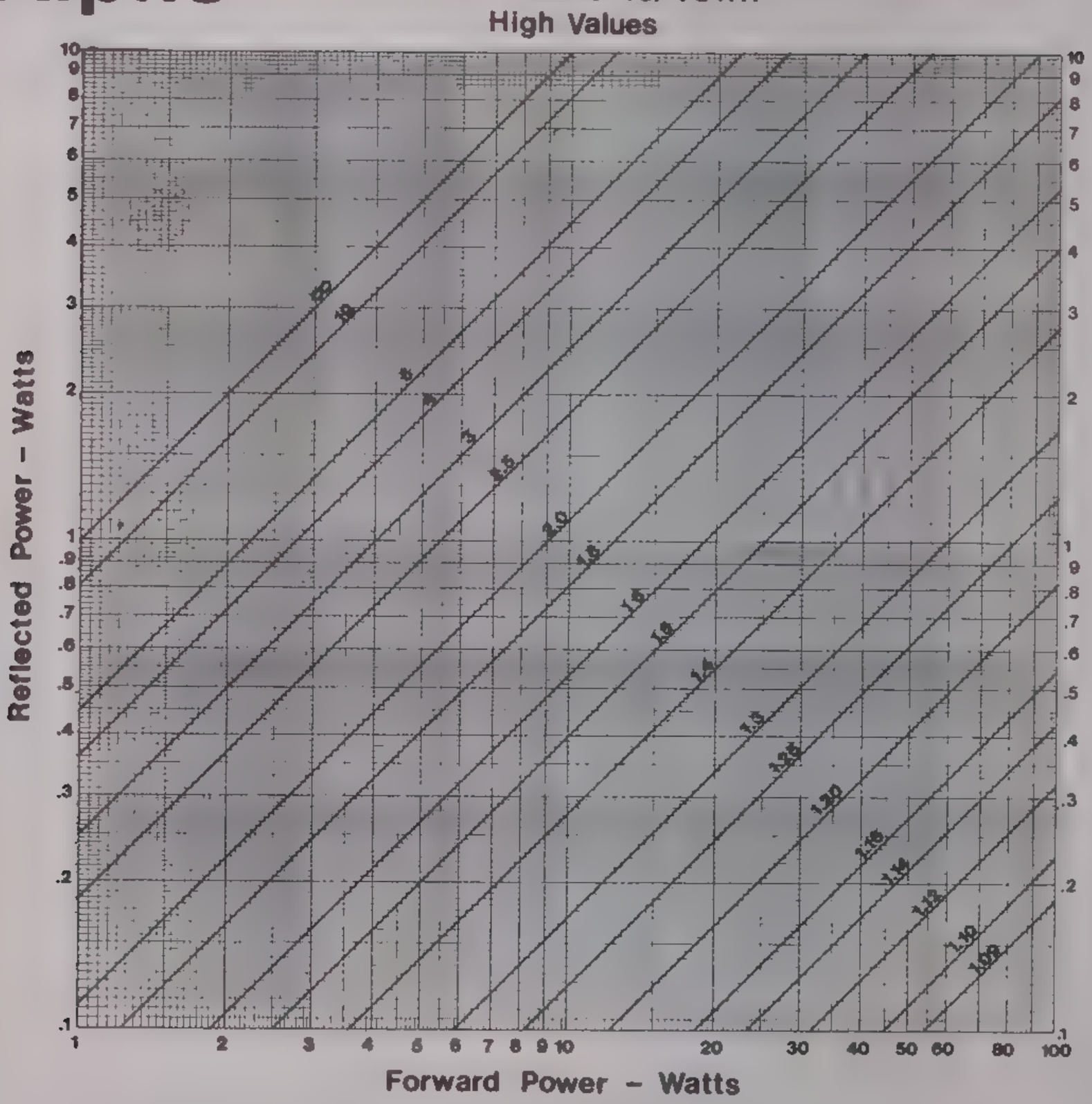


Figure 10. Part Location Details

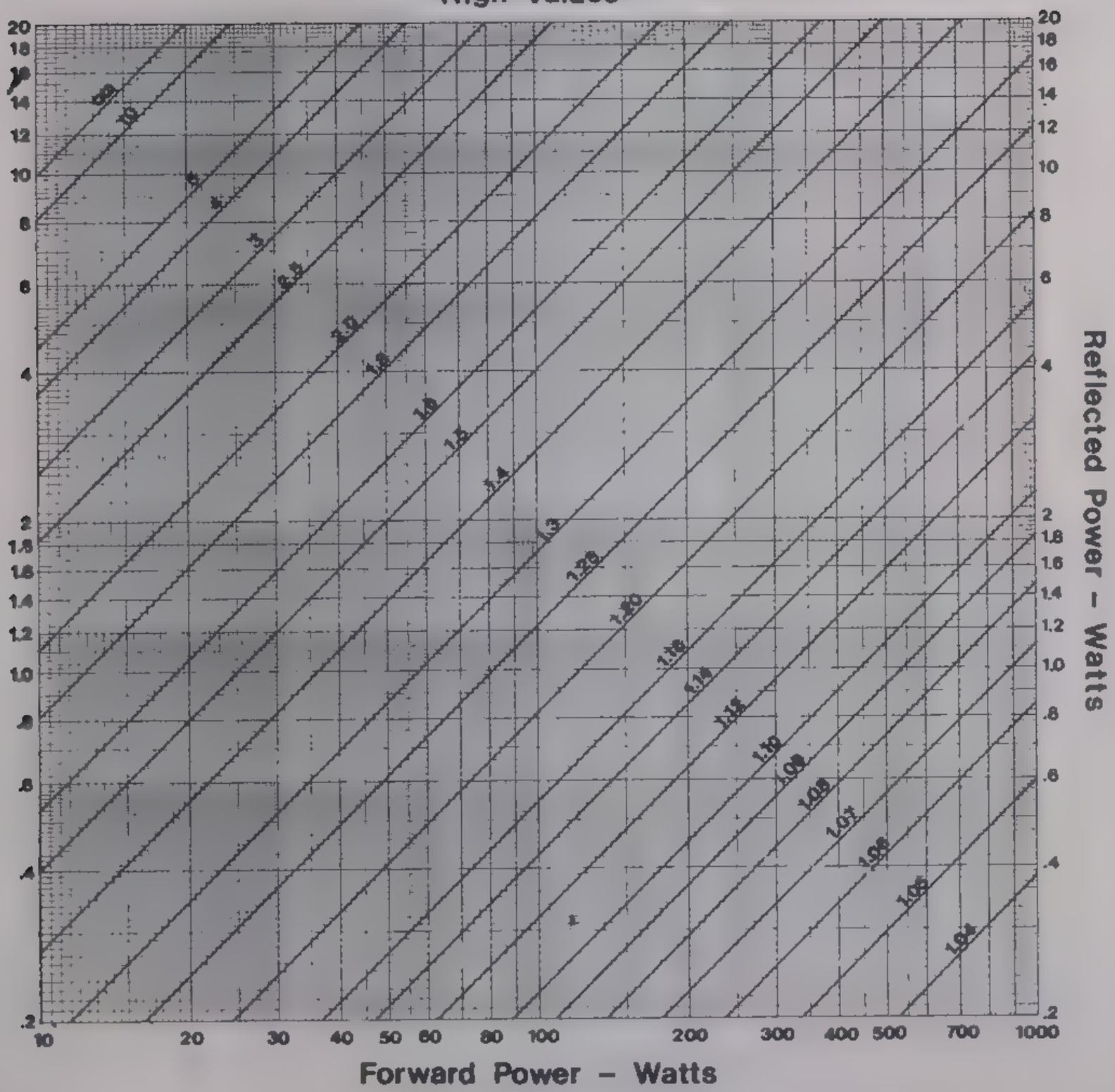
parts list

Code	Part No.	Quan.	Description (Function)
1	15-80310A50	1	Housing (Houses meter)
2	64-80310A51	1	Back panel (Encloses back of housing)
3	75-82554A01	10	Rubber feet (Support)
4	3-114831	4	Screw (Secure feet)
5	3-1930	4	Screw (Secure back panel)
6	14-80310A52	1	"U" channel (Retains element and dc pick up)
7	41-80310A62	2	Retainer spring (Retain element in channel)
8	41-80310A63	3	Contact spring (DC pick up from element)
9	46-80310A61	2	"U" channel stud (Retain channel in place)
10	3-400138	2	Screw (Secure "U" channel in place)
11	3-138195	10	Screw (Hold springs in place)
12	4-7652	4	Flatwasher (Hold stud in place)
13	4-835576	2	Springwasher (Hold stud in place)
14	4-839779	2	"E" washer (Hold stud in place)
15	47-80310A64	1	Shorting bar (Damps meter movement)
16	1-80310A75	1	Meter assembly (Reads power) 50um, 645mV, 12.9k
17	3-1437	2	Screw (Secure meter to body)
18	4-7555	2	Flatwasher (Secure meter to body)
19	4-114583	2	Lockwasher (Secure meter to body)
20	45-80310A58	1	Shutter slide (Indicates reading direction)
21	42-80310A59	1	Shutter retainer (Indicates reading direction)
22	38-80310A60	2	Button (For shutter slide)
23	3-1911	2	Screw (Secure slide to meter)
24	4-124634	2	Flatwasher (Secure slide to meter)
25	4-400139	2	Lockwasher (Secure slide to meter)
26	40-80310A65	1	Switch (Forward/reverse switch)
27	3-1943	2	Screw (Secure switch to slide)
28	4-400130	2	Lockwasher (Secure switch to slide)
29	64-80319A74	1	Plate (Balance)

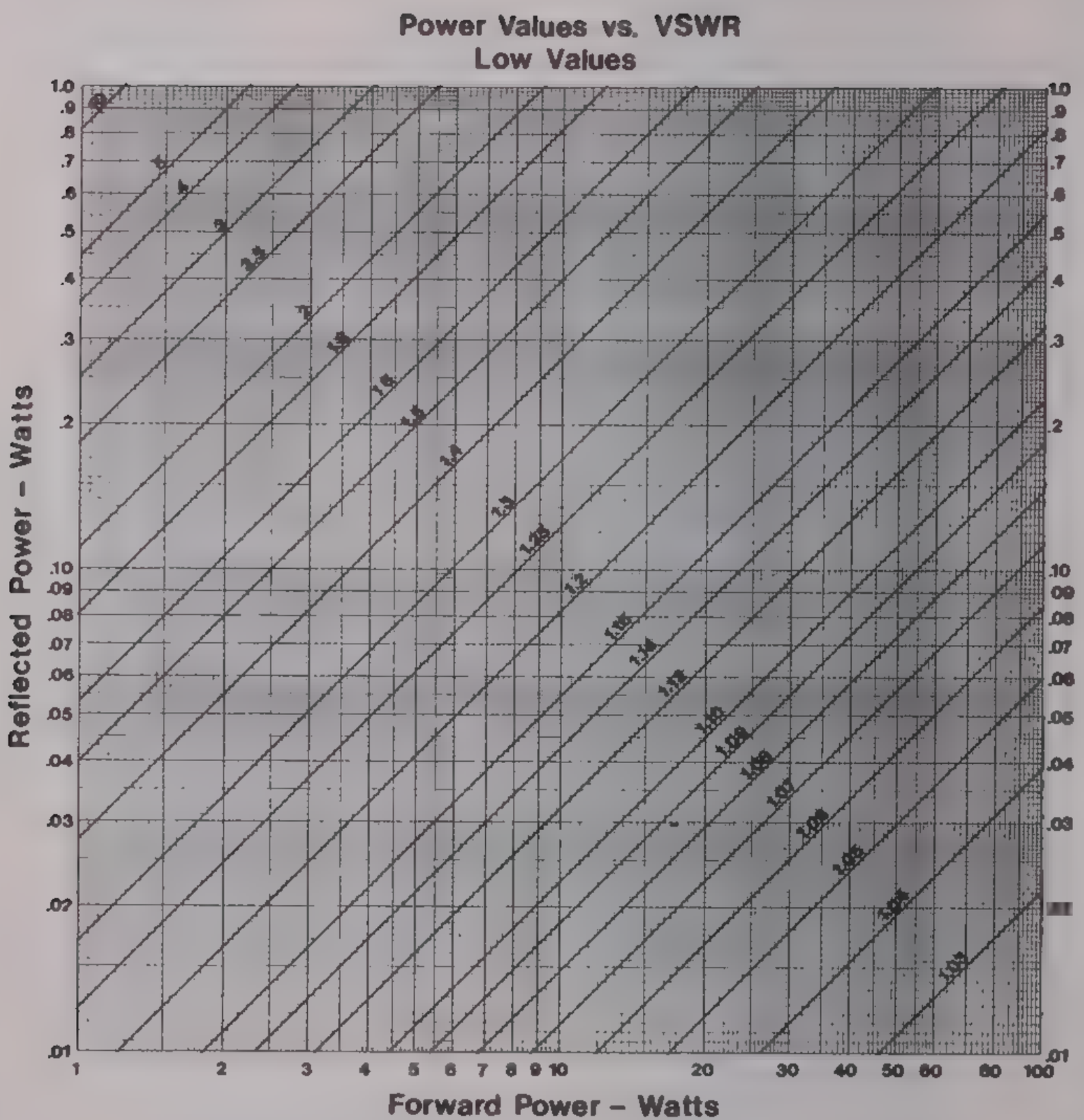
graphs



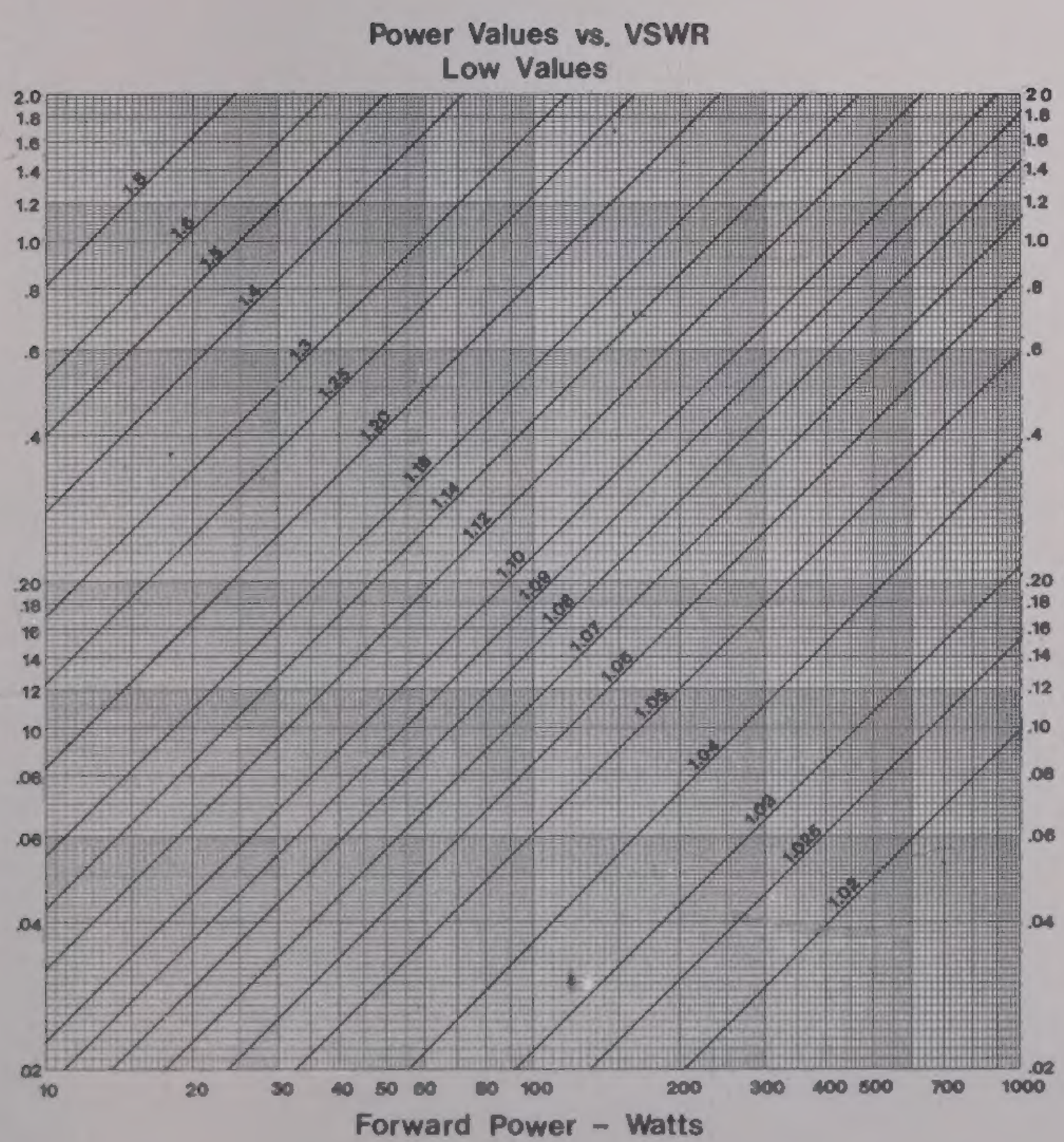
Graph 1. Power Values vs VSWR (High Values)



Graph 2. Power Values vs VSWR (High Values)



Graph 3. Power Values vs VSWR (Low Values)



Graph 4. Power Values vs VSWR (Low Value)

68P81069A33–O